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Name not given

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PATENT REQUEST: STANDARD PATENT

We, being the persons identified below as the Applicant, request the grant of a patent to the person identified below as the Nominated Person, for an invention described in the accompanying standard complete specification. Full application details follow.

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(54) Invention title: PUMP MONITORING APPARATUS

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ASSOCIATED PROVISIONAL APPLICATION DETAILS

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Drawing number recommended to accompany abstract : Fig. 1

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(Date)

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PUMP MONITORING APPARATUS

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Pump monitoring apparatus (10) including a monitoring circuit (11) which may be connected to the pump motor to sense the time that the pump is operating. The monitoring circuit stores information concerning the pump being monitored relating to capacity and efficiency of the pump and provides a flow output reading calculated from time that the pump is operating and stored capacity and efficiency.

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Regulation 3.2

AUSTRALIA

Patents Act 1990

COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

TO BE COMPLETED BY APPLICANT

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Invention title: PUMP MONITORING APPARATUS

Details of Associated Provisional Applications Nos: PM7065

The following statement is a full description of this invention, including the best method of performing it known to me:-

This invention relates to pump monitoring apparatus particularly but not exclusively applicable for monitoring pumps in pumping stations and wet well applications for flow measurement purposes.

Apparatus for monitoring pumps and in particular pump flow rates normally include mechanical or electrical flow meters. This requires the fitting of flow meters into a flow line and thereafter the monitoring of such meters to provide a measurement of flow. Conventional flow meters which generally include moving parts or exposed sensors are not suitable for use in all applications and where used must be maintained to ensure that they continue to function efficiently and correctly. Installation of conventional systems into existing pump stations proves difficult often required major plant shutdown.

The present invention aims to overcome or alleviate the above disadvantages by providing monitoring apparatus which may be associated with a pump or pumps to monitor flow rates from pump or pumps in a reliable and efficient manner. The monitoring apparatus may be incorporated in a pump station management system for monitoring pump operation or for use in wet well applications. The monitoring apparatus of the invention however may also be used in many other applications. Other objects and advantages of the invention will become apparent from the following description.

The present invention thus provides in a first preferred aspect, pump monitoring apparatus, said apparatus including means for sensing the time a pump is operating and means for calculating from said sensed time, and from the capacity and efficiency of said pump, flow of fluid through said pump.

The monitoring apparatus may include memory means for storing information concerning the capacity of the pump and the efficiency thereof which may be used to calculate the flow of fluid. The information entered into the memory concerning capacity and efficiency may be entered manually through a computer such as a personal computer.

In a second aspect, the present invention provides pump monitoring apparatus, said apparatus including database means for storing data relative to a pump to be monitored, said apparatus being adapted to be connected to the control circuit of the motor of said pump to sense the time the motor is operating and therefore the time the pump is operating, and means for calculating from said stored pump data, flow delivered by said pump.

The data base means may store information concerning one or a plurality of different pumps including information concerning flow provided by the pumps and efficiency of the pumps and means may be provided to enable selection from the stored database a desired pump to be monitored. Alternatively, know pump capacities and efficiencies may be entered manually into the data base so as to enable calculation of flow from the time the pump is operating.

The present invention in a third preferred aspect provides monitoring apparatus for use in monitoring a wet-well having a pump associated therewith for pumping fluid from said wet well, said apparatus including means for sensing the time said pump is operating and means for calculating from said sensed time, and from the capacity and efficiency of said pump, flow of fluid through said pump to monitor flow to or from said wet-well.

The information provided by the monitoring apparatus of the invention may be provided on site or transmitted to a remote location. The apparatus may also be programmed to transmit the information via facsimile to any desired facsimile receiver.

In a further aspect, the present invention provides a method for monitoring operation of a pump, said method including the steps of sensing the time said pump is operating, and calculating from said sensed time and stored information concerning the capacity and efficiency of said pump, flow through said pump.

In order that the invention may be more readily understood and put into practical effect, reference will now

be made to the accompanying drawings which illustrate a preferred embodiment of the invention and wherein :-

Fig. 1 illustrates schematically the monitoring apparatus according to the present invention;

Fig. 2 illustrates schematically a typical application of the apparatus of the invention for monitoring pump operation;

Fig. 3 illustrates schematically an application of the apparatus of the invention to wet-well flow measurement; and

Fig. 4 illustrates schematically a further application of the apparatus of the invention to wet-well flow measurement.

Referring to the drawings and firstly to Fig. 1 there is illustrated schematically the monitoring apparatus 10 of the present invention which includes control circuit 11 contained within a housing 12, the housing 12 carrying connections 13 and 14 for connection of the circuit 11 to a pump or pump station, a further connection 15 for connection of the circuit 11 to a power supply and a further connection 16 for connection of a control circuit 11 to a computer interface 17. The control circuit 11 is set up by means of software input through the computer interface 17 which for example may be connected to a personal or laptop computer. The computer is software programmed to allow for entry of information into data storage means, such as a memory, of the circuit 11 concerning a particular pump or pumps to be monitored. The connection 13 may provide the monitoring interface for digital functions for one or a number of pump motors. The circuit 11 through the connection 13 can thus monitor the change of state of each of the inputs at the connection 13. The connection 14 allows for monitoring analogue circuits of the pump and pump station and provides for a number of analogue states of the pump or pump station to be monitored on a separate loop current circuit. Each circuit can be scaled to meet respective input parameters such as motor currents, water level and/or pressure.

The input to the connection 13 are connected to the digital input or output circuits of the pump station. The monitoring circuit 11 can thus use the volt free contacts from the existing pumps motor start contacts control circuits thus eliminating the need for calibration. These connections however provide to the control circuit signals representing the time that the pump/s is/are operating.

In an application to a pump 18 pumping liquid through a flow line 19 as shown in Fig. 2 the monitoring apparatus 10 can be set up to measure flow through the flow line 19 in accordance with the time the pump 18 is operating. The pump 18 is a fixed speed pump driven by an electric motor and its known capacity and efficiencies may be entered into the memory of the circuit 11 using the software program computer. In operation the monitoring circuit 11 which has been programmed by the computer, will monitor the time that the pump 18 operates and from this time will calculate, using the entered pump capacity and efficiency, the flow rate through the flow line 19.

In wet-well applications as shown in Fig. 3, liquid 20 is held within a well 21 and supplied to the well through an inlet 22 and out of the well 21 through an outlet 23, being pumped from the outlet 23 by a fixed speed electric motor driven pump 24 whose operation is monitored by the monitoring apparatus 10. When the pump 24 is not operating, liquid flowing in through the inlet 22 will fill the tank 21 raising the level from level B where the pump 24 is off to the level B where the pump 24 is turned on. At the level A the pump 24 commences operation until it lowers the level of liquid to the level B at which time the pump 24 is turned off. The pump 24 is monitored by the apparatus 10 so as to provide, from the time that the pump is on, a calculation with the inflow rate to provide an accurate outflow. For example if V1 is the volume within the tank 20 between the normal set points A and B and T1 is the time period to fill the volume V1 the inflow rate is calculated by dividing the volume V1 by the time T1. The time T1 is

calculated from a time that the pump 24 is not operating. If T2 is the time required to empty the volume V1 through the outlet 23, the outflow rate is equal to the inflow rate previously calculated plus the volume V1 divided by T2.

The apparatus 10 may also be configured in a wet-well application where two upper set points A1 and A2 control the operation of the pump/pumps (see Fig. 4). The flow calculations are then varied to suit the application. The monitoring apparatus 10 assumes that the additional pump/pumps is/are activated where the wet-well volume reaches the additional set point A1 which lowers the level to A which starts the other pump/pumps. The inflow rate is the previous outflow rate calculated as described with reference to Fig. 3 plus the additional volume V2 between the upper set points A1 and A2 divided by the time period T3 to fill the volume V2. In this instance the outflow rate is calculated by the total volume (V1 plus V2) divided by the total time to empty the volumes V1 and V2 (T2 plus T4, T4 being the time to empty the volume V2) plus the inflow rate. The accumulated outflow is calculated by multiplying the outflow rate by the total time period that the pump/s is/are on.

The monitoring apparatus of the present invention may be retrofitted to existing pump stations where no monitoring exists and furthermore does not require any on-site calibration nor have moving parts or exposed sensors. The software programming of the apparatus 10 allows for particular pump characteristics of flow and efficiency to be simply entered and/or stored to thereby allow for accurate calculation of flow and flow rate from the entered characteristics. Pump efficiency can be calculated on a daily basis, in wet-well applications, without input of external data parameters.

If desired the monitoring circuit 11 may include a facsimile interface 24 through which the operational characteristics of the pump may be transmitted by again programming of a telephone number and facsimile parameters using the software program.

Whilst the above has been given by way of illustrative embodiment of the invention, all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope of the invention as defined in the claims.

CLAIMS

1. Pump monitoring apparatus, said apparatus including means for sensing the time a pump is operating and means for calculating from said sensed time, and from the capacity and efficiency of said pump, flow of fluid through said pump.

2. Monitoring apparatus according to Claim 1 and including memory means for storing information concerning the capacity of the pump and the efficiency.

3. Monitoring apparatus according to Claim 2 wherein said information is entered into said memory via a computer.

4. Pump monitoring apparatus, said apparatus including database means for storing data relative to a pump to be monitored, said apparatus being adapted to be connected to the control circuit of the motor of said pump to sense the time the motor is operating and therefore the time the pump is operating, and means for calculating from said stored pump data, flow delivered by said pump.

5. Pump monitoring apparatus according to Claim 4 wherein said data base means stores information concerning one or a plurality of different pumps including information concerning flow provided by the pumps and efficiency of the pumps.

6. Pump monitoring apparatus according to Claim 4 wherein means are provided to enable selection from said stored database a desired pump to be monitored.

7. Pump monitoring apparatus according to Claim 4 wherein know pump capacities and efficiencies may be entered manually into said data base so as to enable calculation of flow from the time the pump is operating.

8. Monitoring apparatus for use in monitoring a wet-

well having a pump associated therewith for pumping fluid from said wet well, said apparatus including means for sensing the time said pump is operating and means for calculating from said sensed time, and from the capacity and efficiency of said pump, flow of fluid through said pump to monitor flow to or from said wet-well.

9. A method for monitoring operation of a pump, said method including the steps of sensing the time said pump is operating, and calculating from said sensed time and stored information concerning the capacity and efficiency of said pump, flow through said pump.

10. Pump monitoring apparatus substantially as hereinbefore described with reference to the accompanying drawings.

11. Wet-well monitoring apparatus substantially as hereinbefore described with reference to the accompanying drawings.

12. A method of monitoring a pump substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 26th day of July 1995

DUMFORD PTY. LTD.
By Our Patent Attorney

John R. G. Gardner

ABSTRACT

Pump monitoring apparatus (10) including a monitoring circuit (11) which may be connected to the pump motor to sense the time that the pump is operating. The monitoring circuit stores information concerning the pump being monitored relating to capacity and efficiency of the pump and provides a flow output reading calculated from time that the pump is operating and stored capacity and efficiency.

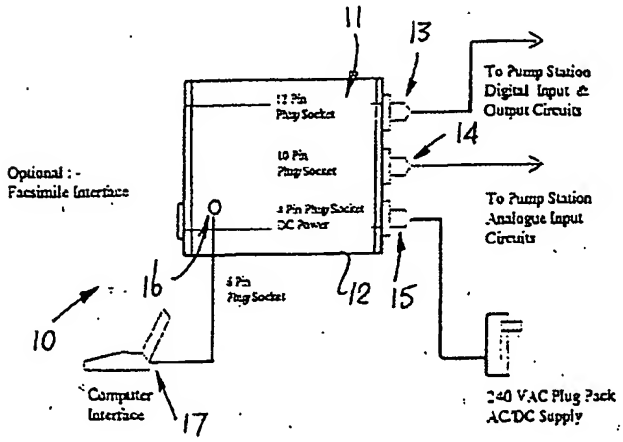
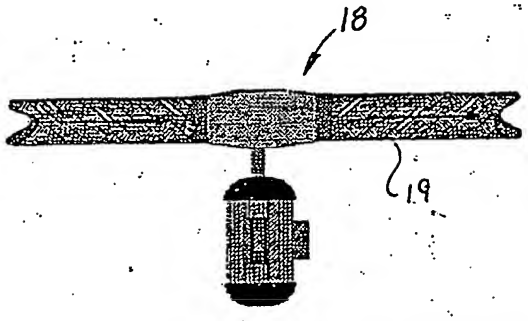
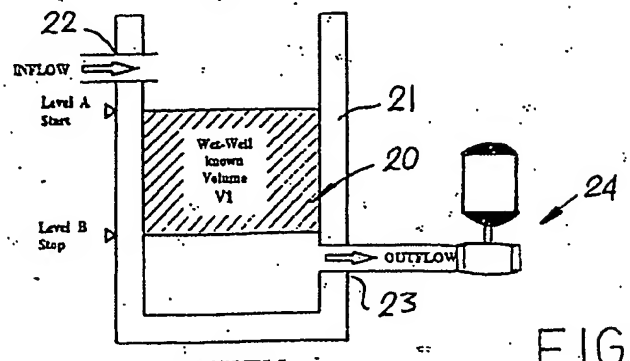


FIG.1



Flow Rate = $\frac{(\text{Pump Capacity} \times \text{Pump Efficiency})}{100} \times \text{Pump Run Time}$

FIG.2



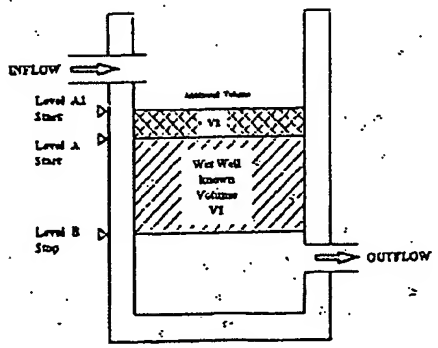
WET-WELL
Normal Set Point Operation

FIG.3

Where: V1 = Volume between Normal Set-Points
T1 = Time period to fill V1
T2 = Time period to empty V1
T6 = Time period when pump/pumps ON.

Inflow Rate (Inf1) = $\frac{V1}{T1}$

Outflow Rate = $\frac{V1}{T2}$ + Inflow Rate (Inf1)



WET WELL
Additional Set Point Operation

FIG.4

Where: V1 = Volume between Normal Set-Points
V2 = Volume between Additional Set-Points
T1 = Time period to fill V1
T2 = Time period to empty V1
T3 = Time period to fill V2
T4 = Time period to empty V2.
T6 = Time period when pump/pumps ON

Inflow Rate (Inf2) = $\frac{V2}{T3}$ + (Previous Outflow Rate)

Outflow Rate = $\frac{(V1 + V2)}{(T2 + T4)}$ + Inflow Rate (Inf2)

Accumulated Outflow = (Outflow Rate x T6) + (Outflow Rate x T6) + (etc.)